terata! Such a mistake is incomprehensible, and certainly much to be regretted.

The Cirripedia, which were regarded by Professor Jones as Mollusca long after every body else had recognized their Annulose nature, are now placed by him in the Articulate series; but he still retains such statements as that "the Cirripedia present a strange combination of articulated limbs with many of the external characters of a mollusk," which would seem to intimate that he feels by no means sure of their true position. And yet one would think that the mode of development of these creatures could leave no doubt as to their being not only Articulata, but Crustacea. But Professor Jones gives but a scanty notice of the interesting metamorphoses of the Cirripeds, and does not seem at all to appreciate their importance. From a similar unappreciation, his classification of the Crustacea is in a very backward state.

But we will carry no further the ungrateful task of fault-finding. The defects that we have indicated, and especially that relating to the Cœlenterata, are, however, of a nature to prevent any thing like a high or philosophical view being taken of the lower divisions of the animal kingdom; and we can only hope that a fifth edition of the work may speedily be called for, and that its author will not allow his conservative feelings again to lead him astray.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

January 19, 1871.—General Sir Edward Sabine, K.C.B., President, in the Chair.

"On the Structure and Development of the Skull of the Common Frog (*Rana temporaria*)." By W. Kitchen Parker, F.R.S.

At the close of my last paper "On the Skull of the Common Fowl," I spoke of bringing before the Royal Society another, treating of that of the osseous fish I was working at the early conditions of the salmon's skull at the time.

I was, however, led to devote my attention to another and more instructive type early in the following year; for it was then (January 1869) that Professor Huxley was engaged in preparing his very important paper "On the Representation of the Malleus and the Incus of the Mammalia in the other Vertebrata" (see Zool. Proc. May 27, 1869).

In repeating some of his observations for my own instruction, it occurred to me to renew some researches I had been making from time to time on the frog and toad. The results were so interesting to us both, that it was agreed for me to work exhaustively at the development of the frog's skull before finishing the paper on that of the salmon. On this account Professor Huxley mentions in his paper (*op. cit.* p. 406) that he leaves the Amphibia out of his de-

monstration, and that they are to be worked out by me. The amount of metamorphosis demonstrable in the chick whilst enclosed in the egg suggested a much more definite series of changes in a low, slow-growing Amphibian type. I think that this has been fully borne out by what is shown in the present paper.

The first of the ten stages into which I have artificially divided my subject is the unhatched embryo, whilst its head and tail project only moderately beyond the yelk-mass. Another stage is obtained by taking young tadpoles on about the third day after they have escaped from their glairy envelope; a few days elapse between the second and third stages, but a much longer time between the third and fourth; for the fourth stage is the perfect tadpole, before the limbs appear and whilst it is essentially a fish with mixed *Chimæroid* and *Myxinoid* characters. Then the metamorphosing tadpole is followed until it is a complete and nimble frog, two stages of which are examined; and then old individuals are worked out, which give the culminating characters of the highest type of Amphibian.

The early stages were worked out principally from specimens hardened in a solution of chromic acid; and the rich umber-brown colour of these preparations made them especially fit for examination by reflected light.

Without going further into detail as to the mode of working my subject out, and without any lengthened account of the results obtained, I may state that the following conclusions have been arrived at—namely, that the skull of the adult is highly compound, being composed of:—

1st. Its own proper membranous sac;

2nd. Of a posterior part which is a continuation, in an unsegmented form, of the vertebral column;

3rd. Of laminæ which grow upwards from the first pair of facial arches, and which enclose the fore part of the membranous sac, just as the "investing mass" of the cranial part of the notochord invests the hinder part.

4th. The ear-sacs and the olfactory labyrinth become inextricably combined with the outer case of the brain. And

5th. The subcutaneous tissue of the scalp becomes ossified in certain definite patches; these are the cranial roof-bones. Around the mouth there are cartilages like those of the Lamprey and the *Chimæra*; but these yield in interest to the proper facial bars, which are as follows, namely:—

First pair, the "trabeculæ."

Second pair, the mandibular arch.

Third pair, the hyoid arch.

And fourth to seventh pairs: these are the branchials.

These are all originally separate pairs of cartilaginous rods; and from these are developed all the complex structures of the mouth, palate, face, and throat. The pterygo-palatine arcade is merely a secondary connecting bar developed, after some time, between the first and second arches.

Meckel's cartilage arises as a segmentary bud from the lower part

of the second, and the "stylo-cerato-hyal" as a similar secondary segment from the third arch.

By far the greater part of the cranium (its anterior two-thirds) is developed by out-growing laminæ from the trabeculæ, which after a time become fused with the posterior or vertebral part of the skull.

When the tadpole is becoming a frog, the hyoid arch undergoes a truly wonderful amount of metamorphosis.

The upper part, answering to the hyomandibular of the fish (not to the whole of it, but to its upper half), becomes the "incus;" and a detached segment becomes the "orbiculare," which wedges itself between the incus and the "stapes." The stapes is a "bung" cut out of the "ear-sac." The stylo-cerato-hyal is set free, rises higher and higher, and then articulates with the "opisthotic" region of the ear-sac; in the toad it coalesces therewith, as in the mammal. The lower part of the hyomandibular coalesces with the back of the pair of the mandibular arch; and the "symplectic" of the osseous fish appears whilst the tadpole is acquiring its limbs and its lungs, and then melts back again into the arch in front; it is represented, however, in the bull-frog, but not in the common species, by a distinct bone.

This very rough and imperfect abstract must serve at present to indicate what has been seen and worked out in this most instructive vertebrate.

January 26, 1871.—General Sir Edward Sabine, K.C.B., President, in the Chair.

"On the Organization of the *Calamites* of the Coal-measures." By W. C. Williamson, F.R.S., Professor of Natural History in Owens College, Manchester.

Ever since M. Brongniart established his genus *Calamodendron*, there has prevailed widely a belief that two classes of objects had previously been included under the name of *Calamites*—the one a thin-walled Equisetaceous plant, the *Calamites* proper, and the other a hard-wooded Gymnospermous Exogen, known as *Calamodendron*. This distinction the author rejects as having no existence, the thick- and thin-walled examples having precisely the same typical structure. This consists of a central pith, surrounded by a woody zone, containing a circle of woody wedges, and enclosed within a bark of cellular parenchyma.

The Pith has been solid in the first instance, but very soon became fistular, except at the nodes, at each one of which a thin diaphragm of parenchyma extended right across the medullary cavity. Eventually the pith underwent a complete absorption, thus enlarging the fistular interior until it became coextensive with the inner surface of the ligneous zone.

The Woody Zone.—This commenced in very young states by the formation of a circle of canals stretching longitudinally from one node to the adjoining one. Externally to, but in contact with, these canals a few barred or reticulated vessels were found; successive ad-

ditions to these were made in lines radiating from within outwards; hence each wedge consisted of a series of radiating laminæ, separated by medullary rays, having a peculiar mural structure. At their commencement these wedges were separated by wide cellular areas, running continuously from node to node; as the woody tissues increased exogenously, these cellular tracts also extended outwards. Radial longitudinal sections exhibited in these the same mural tissue that occurs in the woody wedges. Hence the author gives to the former the name of primary medullary rays, and to the latter that of secondary ones. The structure of the medullary and ligneous zones is compared with that of the stem of a true Exogen of the first year, of which transitional form *Calamites* may be regarded as a permanent representative. Tangential sections of this woody zone exhibit parallel bands of alternating vascular and cellular tissue, running from node to node. At the latter points each vascular band dichotomizes, its divergent halves meeting corresponding ones from contiguous wedges, and each two unite to form one of the corresponding bands or wedges of the next adjoining internode.

The Bark, hitherto undescribed, consists of a thick layer of cellular parenchyma, undivided into separate laminæ, and not exhibiting any special differentiation of parts. This structure exhibits no signs of external ridges or furrows, being apparently smooth. The stem was enlarged at each node, but the swelling was less due to any increased thickness of the bark at these points, than to an expansion of the woody layer at these points, both externally and internally. This was the result of the intercalation of numerous short vessels, which arched across each node, their concavities being directed inwards, and which constituted the portion of the woody zone that encroached upon the constricted pith at these nodes. Several modifications of the above type have been met with, most of which may have had a specific value. In one form no canals exist at the inner angles of the woody wedges; in another, laminæ, like those of the woody wedges, are developed in the more external portions of the primary medullary rays, those occupying the centre of each ray being the most external and latest formed. The primary ray is thus transformed into a series of secondary ones.

In another type the vascular laminæ of each woody wedge are few in number, and the component vessels are the same; but the latter are remarkable for their large size. In a fourth variety, the exterior of the woody zone has been almost smooth, instead of exhibiting the usual ridges and furrows: this variety is also remarkable for the large size of its medullary cells, compared with that of the cells and vessels of the woody zone.

But the most curious modification is seen in a plant previously described by the author under the name of *Calamopitus*, in which round or oblong canals are given off from the medullary cavity, and pass horizontally through each primary medullary ray of the woody zone to the bark. These, being arranged in regular verticils below each node, are designated the infranodal canals. The verticils of small round or oblong scars, seen at one extremity of the internodes

of some *Calamites*, are the results of this peculiar organization. In one species of this *Calamopitus*, instead of the longitudinal canals of the woody wedges terminating at the nodes, they bifurcate, like the wedges with which they are associated, and are continuously prolonged from internode to internode.

The ordinary structureless fossils found in shales and sandstones receive a definite interpretation from the specimens described. The fistular medullary cavities, due in the first instance, *not* to decay of the tissues, but to the rapid growth of the stem, became further enlarged by the entire absorption of the true pith, which commenced after the latter had fulfilled its purpose in the origination of the woody wedges. This process terminated at an undulating line of arrested absorption, the convexities of which projected outwards, opposite the primary medullary rays, and inwards, opposite the woody wedges; and the inorganic cast of the cavity thus formed by a physiological action constitutes the *Calamites* commonly seen in collections. Hence they are not, like the Sternbergiæ, casts of a cavity within a true pith, but their form represents that of the exterior of the medullary tissue. The ridges and furrows of these *internal* casts are not identical in position with the similar undulations of the *exterior* of the woody zone, but alternate with them; so that the ligneous cylinder projects both externally and internally where the woody wedges are located, and contracts, in like manner, at the intermediate points opposite to the primary medullary rays. The thin carbonaceous film which frequently invests these casts is the residue of the altered elements of the woody zone, and possibly also of the bark, which latter has been very liable to become detached from the former. The surface-markings of this carbonaceous film have usually no structural significance, being merely occasioned by the impression of the hardened casts which they invest.

Two kinds of branches are given off by *Calamites*—the one subterranean, springing from peculiarly formed rhizomes, and the other aërial, attached to the upright unbranched stems. The former of these are of comparatively large size, the nodes from which they have been detached being marked by large concave lenticular scars as phragmata. These branches appear to have been given off from central rhizomes in accordance with a regular phyllotaxis, but which varied in different species. The aërial branches, on the other hand, were merely slender appendages to a virtually unbranched stem; they were arranged in verticils round the nodes, in variable numbers. Each branch sprang from the interior of one of the woody wedges, the two halves of which were forced asunder to admit the base of the appendage, and from which its constituent vessels were derived. The branch, deprived of its bark, never appears to have had a diameter equal that of two of the woody wedges; and the rarity of their occurrence attached to the stem seems to indicate that they were deciduous. The bark investing them is not yet known, and the exact nature of the foliage which they bore is also uncertain, owing to discordant testimony respecting it; but there appears no reason for doubting that some of the verticillate Asterophyllites or Annu-

lariæ represent it, though there is uncertainty respecting the actual forms to be identified with *Calamites*. The roots were given off from the lower part of each internode, but above the node, and were apparently epidermal.

There is also considerable doubt respecting the fructification of *Calamites*. Some of the Volkmanniæ have evidently belonged to this group; but only one example retaining its minute organization has yet been found in which the structure of the central axes corresponded with that of the *Calamites*. The relationship to *Calamites* of the fruits figured by Binney under the name of *Calamodendron commune*, which are identical wth the *Volkmannia Binneyi* of Carruthers, is more than doubtful, because of the anomalous structure of their central axes.

After a careful comparison of the organization of *Calamites* with that of the recent Equisetaceæ, the author prefers constituting the former an independent order, distinct from, though allied to, the Equisetums, under the name of *Calamitaceæ*, and characterized by cryptogamic fructification and verticillate foliage, associated with an exogenous axis. The latter feature probably involved the existence of something resembling a cambium layer, furnishing the material for the new tissues.

It is further proposed to divide these plants into two generic groups, viz. *Calamites* and *Calamopitus*—the former to comprehend those unprovided with infranodal canals, and the latter those which possess them. The existing specific distinctions appear to have little or no scientific value.

MISCELLANEOUS.

On a new Species of Three-toed Sloth from Costa Rica. By Dr. J. E. Gray, F.R.S. &c.

Arctopithecus griseus.

Fur very long, greyish white; under-fur very abundant, brown; forehead and cheeks white; crown and temples black; chin and throat brown. *Male* with a yellow patch of soft hair between the shoulders, with a central black streak. *Female* with a puff of very soft white hair on each side of the back.

Hab. Costa Rica (Salvin). Brit. Mus.

On a new Form of Sponge. By Prof. Ehlers.

Aulorhipis elegans, n. g. et sp.

The stratified tissue of this sponge, which encloses many foreign bodies, lines the inner surface of a worm-tube, from the superior opening of which it projects in the form of a little stalk, which forks into two branches bending downwards in the same plane, and gives off from each branch several (eight to ten) twigs directed upwards,